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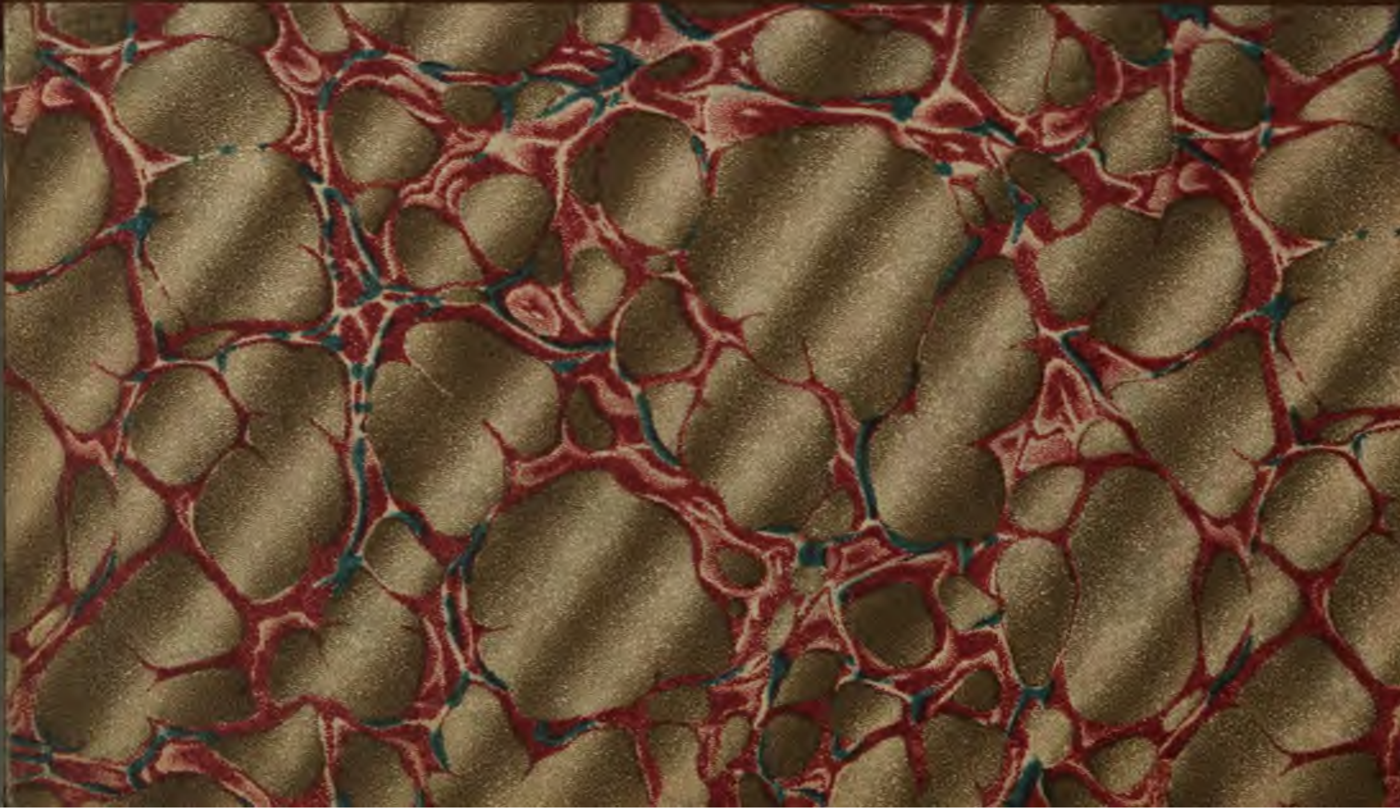

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DESCRIPTION

OF THE

UNIVERSAL TELEGRAPH,

FOR

DAY AND NIGHT SIGNALS.

BY

C [illegible]

C. W. PASLEY,

LIEUTENANT-COLONEL ROYAL ENGINEERS,

AND F.R.S.

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DESCRIPTION

OF THE

UNIVERSAL TELEGRAPH,

&c. &c. &c.

1st. *INTRODUCTION.**

In the year 1804, whilst inquiring into the subject of Telegraphs, I remarked the inferiority of all the Land Telegraphs then in use, when compared with the Naval Telegraphic system of Flags and Pendants, inasmuch as the latter were capable of exhibiting three letters or numbers at the same time, whereas the former could only exhibit one letter or one number. And it appeared to me desirable, to extend the powers of the Land Telegraph, if possible, to the same degree.

But on turning my attention to this object, I found that it could not be effected by any modification of the Telegraphs then in use, for by increasing the number of parts of these Telegraphs, it appeared, that they would run into confusion, before a sufficient number of combinations could be attained.

For example, the then Admiralty Telegraph proposed by Lord George Murray consisted of six large equal boards or shutters, disposed in two vertical tiers in the form of a rectangle: and to have increased the number of these to 24, or at least to 20, which would have been absolutely necessary, in order to telegraphe four letters simultaneously, would evidently have created a mass of inextricable confusion. And in like manner the five arms of the Reverend J. Gamble's radiated Telegraph, if increased to 20, although distributed upon four different posts, appeared to me almost equally objectionable.

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* Besides the Telegraph herein described, many others, both of a prior and subsequent date are alluded to, of which figures are given in Plate III. The reader is therefore recommended to inspect that plate, and to peruse the references to it, before he begins to read this paper; also to refer to it occasionally, when necessary.

It seemed no less impossible to arrive at the object in view, by any modification of the French Telegraph, then in use, invented by M. Chappe, as the signs or characters represented by it, were much too like hieroglyphics, to admit of several such characters, being clearly distinguished, at one glance of the eye.

These three were the only Telegraphs, of which I had any knowledge at that time, and I had no means of acquiring further information, being then stationed in the Island of Malta.

Impressed, therefore, with the necessity of reducing this useful machine to its simplest possible form, the idea of the two armed Telegraph, described in this paper occurred to me, which may be allowed to be the simplest kind of effective Telegraph that has yet been proposed.

In the year 1805, I sent a model and description of this Telegraph to General Morse, then Commanding the Corps of Royal Engineers, requesting that he would lay the same before the Board of Ordnance,* which however was not done, by reason that the subject was not considered as falling within the province of that Department.

On my arrival in England, in the beginning of 1807, an offer was made by me, through a friend, to lay my plan before the Admiralty. On communicating this intention to the Secretary, my friend was informed, that the then Lords Commissioners of the Admiralty were not likely to pay any attention to my proposal, as "they were perfectly satisfied with the telegraph "then in use, than which they neither desired a better nor a "worse." After this, I was advised to lay my plan before the Society for encouraging Arts and Manufactures, with a view to have it published in their transactions, but on calling personally on the Secretary of that body, I received from him a still more repulsive answer, than the above.

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* In the preceding year, 1804, I had already made my plan generally public, by communicating it to Colonel Dickens, to Lieut.-Colonel (then Lieutenant) Burgoyne, and other Officers of the Royal Engineers, doing duty in Malta; to Major (then Captain) Stewart Maxwell, of the Royal Artillery, to Captain (then Lieutenant) John Tailour, of the Royal Navy, to Lieut.-Colonel Sir James Malcolm (then Captain) of the Royal Marines, and to a great number of other Officers, both Naval and Military; as also to Mr. Coleridge, Dr. Stoddart, and other Gentlemen holding Civil situations in that Island.

Being discouraged by these circumstances, from laying my Telegraph in an official manner, before any public body or Society, I published an account of it, the same year (1807), in Tilloch's Philosophical Magazine (Vol. xxix, Page 292) under the title of a Polygrammatic Telegraph for Day Signals; for at that time, with a view of Telegraphing four letters or numbers simultaneously, I proposed to erect four posts with arms complete, at every signal station, each constituting a perfect Telegraph of the simple form described in this paper.

In 1809, when employed on the Walcheren Expedition, I saw for the first time the French Coast Telegraph, since known by the name of the Semaphore, the resemblance of which to my plan immediately struck me. For it had three arms exhibiting positions similar to mine, but placed on separate pivots, vertically over each other, upon the same post.

Early in 1810, I published an account of the French Coast Telegraph, in Tilloch's Philosophical Magazine,* with remarks upon it, accompanied also by a plan of a Polygrammatic Telegraph on a new construction, precisely similar to my former one, excepting that the pairs of arms used were placed upon one lofty post, instead of several short ones. For at that time, I still remained of opinion, that it was desirable to exhibit simultaneously, more letters or numbers than one.

This second plan of a Polygrammatic Telegraph, to which I have just alluded, was afterwards published without acknowledgment, by Lieut. Colonel John Macdonald, in his System of General Telegraphic Communication, in 1817, and the same was subsequently laid before the Society for encouraging Arts, &c. by Harris Nicholas, Esq., of the Inner Temple, in 1821, who received a premium from that Society for his supposed improvement. Being aware, that the same idea may often occur to different persons, who are investigating the same subject, unknown to each other, I mention these facts, not out of disparagement to the above Gentlemen, but merely with a view to assert my just claim to the priority of invention.

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* See Vol. xxxv, Page 339. I believe that this was the first account of that Telegraph, published in England, although I have been informed, that it had been observed by the Officers of the Royal Navy, cruising off the French coast, so early as 1806 or 1807. The French Semaphore, which was established along the Sea coast only, has, I believe, been disused since the peace. In all the principal lines of Telegraphic communication, radiating from Paris, the original French Telegraph still prevails.

In 1816, at the suggestion of Sir Home Popham, Semaphores were established by the Lords of the Admiralty, in place of the former construction, to which their predecessors had been so exclusively attached.

Sir Home Popham's Semaphores, although avowedly an imitation of the French Telegraph of that name, bear a much greater resemblance to the plan published by me in 1807. His Land Semaphore consists of two arms, moveable on the same upright post, but on different pivots. In his Ship Semaphore, finding height an inconvenience, he placed his two arms, each on a separate post.

I was for several years inclined to believe, that Sir Home Popham's modification of the two armed Telegraph, was an improvement upon my original plan, inasmuch as by placing his two arms upon different pivots, he has nearly doubled the number of signs or combinations, which this species of Telegraph is capable of making.

Recently, however, on inquiring into the present most approved practice of telegraphing, as established by the Admiralty, both for their land and sea signals, I find that the extra signs, which may be made by Sir Home Popham's Semaphores are absolutely useless; and that there are the strongest practical objections against his Ship Semaphores; so that my Telegraph, which is equally adapted for the shore and for the sea, and which is a smaller, simpler, and more economical machine than either, may justly claim the preference to both. And if this be admitted, such is the similarity between his plans and mine, that his Land Semaphore may be converted into a Telegraph on my principle, merely by lopping off 16 or 18 feet of superfluous wood and iron work from the top of it, and his Ship Semaphore may undergo the same change, by doing way with one of the two posts, which is not merely useless, t prejudicial, as will afterwards be explained.

Having of late paid greater attention, and made more minute inquiries into this subject, both theoretically and practically, than at any former period, I have been induced to form an opinion, that the advantages proposed by a Polygrammatic Telegraph, or one capable of exhibiting several letters and numbers simultaneously, would be found fallacious in practice. For it is certain, that no Telegraph can possess such extraordinary powers, without having a proportionate multiplicity of parts, which will render it in the like proportion, so much the more unwieldy and expensive, so far as regards the construction and repairs; so much the more difficult to the inexperienced signal man to learn; and so much the more embarrassing to the eye of the observer. Hence, what such a Telegraph may gain in power, will necessarily be lost, either in celerity or in accuracy, independently of its requiring a larger, and more expensive establishment of signal men, than would suffice for a simple instrument.

In fact, taking into consideration, that in the Polygrammatic Telegraph, three or four sets of objects are to be observed, and that two, or more, operative signal men are to be directed; it cannot be expected, that the successive changes upon such an instrument should be so rapid and precise, as in the simple Telegraph, in which one set of objects only is to be observed, and only one operative signal man is to be directed.

Upon these grounds, I have been induced to abandon the principle of the Polygrammatic Telegraph,* although a very pleasing speculation, and which, by degrees, led to the simple instrument, which I have called the Universal Telegraph, in allusion to the property which it possesses, of making Telegraphic signals, on the same system, both by day and night.

Before I proceed further, I wish it to be distinctly understood, that, excepting under some very peculiar circumstances, such as seldom occur,† I consider nocturnal signals on shore, as of little value, even in situations where day signals may be of great importance. If, therefore, the Telegraph described in this paper should hereafter be adopted, I would recommend the apparatus, necessary for making nocturnal signals, to be dispensed with at all inland stations, as it may easily be added, at any future period, in case of emergency.

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* The numerous projects of Lieut.-Colonel Macdonald are all polygrammatic, but limited to the simultaneous exhibition of numerals only, according to the telegraphic system, formerly in use in the Royal Navy.

† Night signals, to communicate between the British Military posts, were established in Ceylon in 1818, during the insurrection of the natives, by order of Lieut.-General Sir R. Brownrigg.

But on board ships of war, and at signal stations on the coast, intended to communicate with shipping, the nocturnal apparatus is perhaps the most important part of the instrument, since it affords a facility of Telegraphic communication by night, to which the present system of Naval Signals is absolutely inadequate. It would be superfluous to enlarge upon the value of this improvement to fleets and convoys, or to vessels in distress.

2nd. *GENERAL DESCRIPTION of the UNIVERSAL TELEGRAPH.*

For the day signals, the Telegraph consists of an upright post of moderate height, of two moveable arms fixed on the same pivot near the top of it, and of a mark, called the indicator, on one side of it (See Plate I. Fig. 1).

Each arm can exhibit the seven positions 1, 2, 3, 4, 5, 6, and 7, exclusive of its quiescent position, called "the stop," in which it points vertically downwards, and is obscured by the post. Fig. 1, Plate I, represents the Telegraph exhibiting the sign, 17, the other positions, of which the arms are capable, being dotted. The indicator merely serves to distinguish the low numbers, 1, 2, and 3, from the high numbers, 7, 6, and 5, so that this Telegraph is not, like most others, that have been proposed, liable to ambiguity or error, when viewed from different points in contrary directions.*

The use of the indicator will appear more evident, on considering the resemblance between the small Roman letters, b and d, or p and q, which, if viewed in contrary directions, like Telegraphic signs, could never be distinguished, one from the other, without some additional mark.

---

* The idea of the indicator, which was not a part of my original plan, but without which, I am now of opinion, that no Telegraph is perfect, suggested itself, in consequence of a remark made by my friend Captain John Tailour, of the Royal Navy, who informed me, that he had experienced the greatest inconvenience, in using Sir Home Popham's Ship Semaphores, from the signal men confounding the positions of the arms, when seen in reverse.

Fig. 2, Plate I, represents the Telegraph fitted up for making nocturnal signals. One lantern (*a*), called the central light, is fixed to the same pivot, upon which the arms move. Two other lanterns are attached to the extremities of the arms. A fourth lantern (I), used as an indicator, is fixed on the same horizontal level, with the central light, at a distance from it equal to twice the length of one arm, and in the same plane nearly, in which the arms revolve. Hence the whole apparatus consists of two fixed, and of two moveable lights, four in all.

The number of telegraphic signs, combinations, or changes, which this Telegraph is capable of exhibiting, are only 28, but these are amply sufficient, for every purpose of Telegraphic communication, whether by the alphabetical method, or in reference to a Telegraphic Dictionary of words and sentences. These signs are represented in Plate II, in a double column, shewing the appearance of the same combinations, both by day and night.

In some few of the nocturnal signs, it will be observed, that one of the lights is marked black. This only happens, when one of the moveable lanterns is supposed to be in its quiescent position, hanging vertically down below the center light. In this case, as the lantern may be exhibited on either side of the post, it may sometimes be seen, and sometimes not, by the distant observer.* At first I proposed to interpose a couple of screens, one on each side of the post, to hide the lanterns altogether, when in this position. Afterwards that idea was abandoned, it having been found, in practice, that it made no difference in regard to the clearness of the signs alluded to, whether the moveable lanterns were seen or obscured, when in the position denoted by the black circles.

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* A great difficulty is hitherto said to have attended the night signals in the Royal Navy, in consequence of the embarrassing circumstance of one or more of the lights exhibited being liable to be extinguished, by eddy winds thrown off from the leaches of the sails, in stormy weather.

Admitting that this difficulty should prove insuperable, upon which point I shall not presume to decide, a question arises, as to the best and simplest mode of guarding against mistakes arising from this cause, which in *General Signals*, relating to manœuvres, might lead to unpleasant, if not to pernicious, consequences. An effectual remedy for this evil (in fact I see no other), is to make a rule, of never exhibiting any sign with fewer than four lights. This being understood, if the signal men, who receive a message, should at any time observe fewer lights than four, they will know that an accident has occurred, in consequence of the wind, and they will therefore take no notice of the apparent sign displayed, until the complete number of four lights again appears.

This arrangement can be adopted, in regard to the nocturnal Telegraph described in this paper, by exhibiting the quiescent light always in front of the post, when two ships only are telegraphing to each other, but a little to one side of it in telegraphing both to the front and rear; also by disusing the sign called "the stop," in which two or three lights only appear, and exhibiting one of the *preparatives* always in lieu of it.

The indicator, both by day and night, being merely a mark and nothing more, which, when once seen, requires no farther attention to be paid to it; and the central light by night, and the post by day, being also merely guides to the eye; the signs of this Telegraph are, in reality, composed of the combinations of two moveable bodies only by day, and of two moveable lights only by night, being the smallest number of parts, with which an efficient Telegraph can possibly be formed: and in this diminution of the number of combinable parts, as well as in the unity of plan, consists the superior simplicity of this Telegraph, as compared with other efficient Telegraphs, that have been proposed.*

3rd. The MECHANICAL CONSTRUCTION of the UNIVERSAL TELEGRAPH.—(Plate I. *Figs.* 3 *and* 4*).*

The arms and the indicator for the day signals are made of wood, framed and pannelled, for the sake of lightness.† The indicator plays in a mortise, cut in the upper part of the post, and is let down into its horizontal, and raised into its vertical, position, by means of a small rope, and a small pulley. The arms must be fixed externally, one on each side of the post, and must be exactly counterpoised, by means of light frames of open iron work, which become invisible by day, at a little distance, and which, even when viewed closely, do not impair the clearness of the Telegraphic signs. This precaution is absolutely necessary, otherwise the arms will not remain in any given position, without being held by the hand, or stopped by some mechanical contrivance, which would be a very great inconvenience in the practice of signal making.

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* Dr. Hooke's Telegraph consisted of more than 30 bodies, each forming a distinct Telegraphic sign or symbol. The original French Telegraph, and the French Semaphore, each consist of 3 moveable bodies. Another Telegraph, proposed in France, consisted of 7. Mr. Edgworth's first plan, which he called "the Tellograph," consisted of 4. Mr. Gamble's Telegraphs generally had 5 bodies, with the exception of one, which consisted of 4 bodies only. The old Admiralty Shutter Telegraph consisted of 6. Lieut.-Colonel John Macdonald, in his Shutter Telegraph, published in 1808, proposes to use no less than 13 bodies, besides a rod with a ball and vane, afterwards added, to act as an indicator. Sir Home Popham, in his Semaphores, used only 2 bodies, like me, but not in so simple a form.

Mr. Edgworth's final plan is still simpler than mine, and, in its principle is, undoubtedly, the simplest of all possible Telegraphs, since he uses one moveable body only. But this can scarcely be considered an efficient Telegraph, for reasons that will hereafter be stated. Two moveable bodies, or moveable lights, may therefore be pronounced to be the minimum of Telegraphic power, suitable to practicable purposes.

Of fixed bodies, or of fixed lights, each having only one position, five may be considered the minimum, four being insufficient for the purposes of alphabetical communication, which I conceive ought never to be abandoned altogether. To the above-mentioned number, as applicable to night signals, two fixed lights, must be added to guide the eye. Hence a proper nocturnal Telegraph can not, possibly, be formed with fewer than *seven* fixed lights, without sacrificing the very useful principle of the indicator.

† In a very hot climate, plates of light copper may be used for the pannels.

Motion may be communicated to the Telegraphic arms, by means of an endless chain, passing round, and acting upon a couple of pulleys; one of which is fixed to the arm itself, and turns upon the same pivot, whilst the other moves upon a pivot, fixed to the lower part of the post. The chain consists alternately of single and double plates, of an oblong form, and rivetted together at the ends, on the principle of a watch chain. The two pulleys at top and bottom being finished with great care, perfectly equal, and having projecting teeth, or studs, fixed in a groove in each, to engage the double or open parts of the chain, the Telegraphic arm above will always follow to a hair's breadth, the movements of an index, or lever, below, attached to the lower pulley, which has a dial plate opposite to it, marked on the post, for the guidance of the operative signal man.*

In the field, or on board ship, a leathern strap or a rope may be substituted in lieu of the chain, for the sake of economy; but as these expedients are incapable of the same accuracy as the former, the signal men, in working by them, must not trust to the indices, but must regulate the positions of the arms chiefly by the eye. The surface of the pulleys, when intended for a strap, must be moderately convex, those for the rope moderately concave, and both should be broader than when a chain is to be used. The leathern strap requires an extra pulley of a smaller size, for pressing in one side, and tightening it, when the Telegraph is to be used. This pulley is fixed to a small lever attached to the middle of the post, and is thrown into action by a string.

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* The chain is first passed loosely round both pulleys, after which the pivot of the lower pulley is acted upon by a couple of screws, to force it down a small vertical groove in the post, by which means the chain is tightened, and rendered fit for use. I had a Telegraph constructed in this manner at Chatham, in 1817, by Mr. Robert Howe, Clerk of Works in the Royal Engineer Department, of which a model was sent to the Secretary of the Admiralty, in 1818.

The above method of moving Telegraphic arms by means of the lever and chain, is much more expeditious, and also simpler in point of workmanship, than the winch and wheel work, and endless screw rods, originally adopted for the same purpose, in the Admiralty Semaphores. In fact, in moving the arm from one position to another, the chain will work at least four times quicker than the winch.

When a rope is used, three turns of it are taken round each pulley, hauling it taught at the same time, after which the two ends, being previously prepared with thimbles, or eyesplices, are brought towards each other, and made fast, by a lanniard, or smaller rope, passing through the eyes.*

When the strap or rope are used, the lower pulley, instead of having one short lever only, serving as an index, may have four such levers, so as to resemble a small winlass.

At the end of each arm, two light pieces of iron, meet in an angle of 45 degrees, forming an open triangle, to the vertex of which the moveable lantern (L) is attached, by means of a pin. A cylindrical weight (W) must be fixed at the same time to the end of the iron counterpoise, to restore the proper equilibrium of the arms, which is, of course, deranged by the addition of the lantern (see figures 3 and 4).† As the lanterns and weights, and, in short, every addition necessary for exhibiting the nocturnal signals, are fixed at dusk, and removed by daylight, it becomes necessary, at permanent stations, that the roof of the signal house, over which the Telegraph stands, shall be formed with a small flat terrace, accessible by means of a ladder or staircase.

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* This contrivance is used for working the present Admiralty Ship Semaphores. Its great simplicity recommends it for the sea service, although in other respects not the most convenient method.

† By this arrangement of the iron-work which supports the lanterns, they always hang clear of it in the regular positions, and the iron counterpoises are made so much shorter than the wooden arms, that the former cannot obscure the lanterns as they revolve. The open space in which the lanterns hang, when in number 4 position, should be about 18 inches high, if large ones are used. But as it may not always be convenient to increase the length of the arm so much, let the iron-work project only 1 foot, beyond the end of the wooden arm, but let the latter have a hinge, by which about 6 inches of it may double up, in order to increase the depth of the open part for the night signals. See fig. 3, in which these hinges are represented.

In the intermediate stations of a permanent Telegraphic line on shore, two lanterns are required to do the duty of the center light, one on each side of the Telegraphic post, because one lantern can, of course, be seen in one direction only, owing to the intervention of the post. These two, as well as the two moveable lanterns are fixed externally, at a sufficient distance from the plane of the arms, to prevent them from striking, as in fig. 4, in which C C are the central lanterns, L L the moveable lanterns, and W W the weights, added to counterpoise them.

The indicator light (I) may either be fixed to a separate post, as represented in fig. 2, or it may be attached to a rod (r), strengthened by a brace (b), and guy ropes (g g), as in fig. 3, which is an elevation of the Universal Telegraph, fitted up for night signals, on a scale larger than that of the former explanatory figures. The apparatus now alluded to, having only one lantern to support, may be made extremely light. The end of the rod drops into a small open mortise at the head of the post, and has a semicircular groove on its lower surface, which is engaged by a horizontal bolt, driven through the sides of the post. A small rope fixed to the end of the rod, but omitted in fig. 3, for the sake of clearness, is made fast to a cleat upon the post below, to prevent the rod from moving. The foot of the brace is secured to the post by a plate and stud.

This apparatus, which entirely depends upon the Telegraphic post, and turns with it, may be fixed, or disengaged, in a moment, and is peculiarly adapted for ships, and for field service, in which the length of the Telegraphic arm does not exceed from 5 to 6 feet. But at permanent stations on shore, where larger Telegraphs would probably be used, the apparatus for supporting the indicator lamp, should be a permanent fixture, to save the trouble of continually shipping and unshipping it. At such stations, if the signals were required to be made in various lines or directions, the pole for supporting the indicator lamp should be fixed to the post at bottom, so as to stand out from it obliquely, like a ship's bowsprit, with lifts, or ropes, to support it, leading to the top of the post, and a couple of guys, to secure it from lateral motion. Hence one oblique spar only would be used, instead of the two pieces (namely, the rod and brace) before described. But as there may be many stations in a Telegraphic Establishment on shore, in which the signals require to be exhibited in one invariable line only, at all such stations, the indicator lantern should be fixed to its own separate post, which may either be placed vertically (as in fig. 2), or obliquely, as may be considered most expedient.*

Lamps for burning oil have recently been brought to such perfection, that a light of sufficient intensity, for any distance suitable for Telegraphic purposes, may easily be obtained. In regard to form, if night Telegraphs be adopted on shore, square lamps, like those of mail coaches, but having the two glass sides opposite to each other, so as to show light in two directions only, would be the most proper. But for sea service, the pattern called the "globe lamp," which has of late been generally adopted in the Royal Navy, in lieu of their former signal lanterns, appears to be decidedly the best. In this, the light is exhibited in every direction through a very strong globular glass, to which are fitted a copper top and bottom, pierced with air holes.†

In respect to the dimensions proper for the parts of the Universal Telegraph, we ascertained by experiment, that the arms for the day signals should be about 1 foot in length per mile, in order to be distinguished by a common portable telescope of moderate power. This length is computed from the center of motion to the end of the arm, not including the small part beyond the center, called the head. By the above rule, a Telegraphic arm, of 6 feet in length, may suffice for stations 6 miles apart; but generally speaking, in Telegraphs intended for permanent stations, where the saving of weight is less an object, it may be considered best to add a little to the dimension thus found.

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* The oblique position is, of course, only recommended, when the roof of the signal house is too small to admit of the indicator lamp post being fixed vertically, which may sometimes happen.

† I am informed that Lord Cochrane originally proposed the globe lamp, but the pattern to which I allude, is considered an improvement. I have not been able to ascertain the name of the patentee, or maker. The large lamps of this description sold in Chatham, and the stage coach lamps used by the principal proprietors on the Dover Road, were both seen distinctly at the distance of 6 miles in clear weather.

The width of the arm need not exceed $\frac{2}{15}$ths of its length, and should not be less than $\frac{1}{7}$th or $\frac{1}{8}$th of the same dimension.* The indicator for the day signals should be of the same width, but only $\frac{4}{5}$ths of the arm in length.

The height of the post should be such, that men, or other moveable objects, passing near it, shall not obscure the indicator, or arms, when the Telegraph is erected on the deck of a ship, or in the field. But when placed on the roof of a permanent signal house, the projecting part of the post need not exceed the Telegraphic arm, by more than $\frac{2}{3}$rds of the length of the latter.

It is desirable in all cases, that the Telegraphic post should be capable of turning, so as to exhibit the arms in various directions.† On board ship it must also be occasionally lowered. Hence it becomes necessary to step it upon a simple open circular joint of iron, fixed to the ship's side near the deck, and to secure it by an iron clamp, also of a circular form, attached to the rail, nearly in the same manner as the ensign staff of a man of war is usually fitted.

The Telegraphs, hitherto constructed upon this principle, are of two sizes. One having arms of 5½ feet in length,‡ with the lantern pivots placed 6½ feet from the center of motion. The other having arms of 2½ feet in length only, with the lantern pivots 3 feet 2 inches from the center of motion. The former are of a size suited to the largest class of men of war. The latter are perfectly portable, as the whole apparatus, including the night indicator, lanterns, &c. does not weigh more than 34lbs.

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* Having fixed the length of the Telegraphic arm, there is in the signs exhibited thereby, as in the capital letters of the Roman alphabet, a certain proportional width, not only pleasing to the eye, but which cannot be diminished beyond a certain limit, without causing the characters to become indistinct. On board ship, where the Telegraph may often be seen obliquely, a broad arm is more essential, than at the fixed Telegraph stations on shore, where this inconvenience seldom occurs.

† Because, even at permanent stations, not required to make signals in more than one alinement, the power of turning enables the signal men to adjust the arms, and the chains, or other contrivance for moving them, when necessary, without needlessly attracting the notice of the corresponding stations.

‡ Which corresponds with the size of the present Admiralty Ship Semaphores.

In clear weather, these small Telegraphs make signals distinctly at the distance of three miles.

Supposing that Telegraphic signals should be required on a sudden emergency, in some situation, where there may not be time and means for making well finished Telegraphs, in the manner that has been described, I have ascertained by experiment, that the most expeditious and satisfactory arrangement will always be to copy the regular construction, as closely as circumstances will permit. A post, with two planks for the arms, each worked merely by a couple of strings without pulleys, will constitute a day Telegraph, and the addition of lanterns, &c. will convert the same simple apparatus into a nocturnal Telegraph. In both cases, the arms must be counterpoised by wood, or iron, and also by weights, but in a ruder manner than was before described. To adopt balls, or flags, for day signals, or an immoveable rectangular frame, with ropes and pulleys, for supporting the lanterns, for night signals, which are the only other expedients, that suggest themselves, as a temporary arrangement, will, on trial, be found much less satisfactory, than the rudest attempt at the counterpoised Telegraphic arm.

It is well known, that Telegraphs should generally be painted black, and that for permanent stations, they should always be erected, if possible, upon heights having no back ground.*

4th. Of a TELEGRAPHIC DICTIONARY, suited to the UNIVERSAL TELEGRAPH.

Several Telegraphic Dictionaries have been composed by different authors, but of all that I have seen, the one now used in the Royal Navy, which was compiled by the late Rear-Admiral Sir Home Popham,† appears, upon the whole, to be the most judicious. The number of words and sentences contained in it does not exceed 13,000; and yet I have seldom observed a deficiency of any useful word. Another author has composed a Dictionary of a similar nature, containing upwards of 31,600 words and phrases: and a third has composed a work containing more than 140,000 words, phrases, and sentences. It may be observed, in regard to this subject, that the extension of a Telegraphic Dictionary beyond a certain limit is an evil, because in proportion to the number and length of the sentences contained in it, it becomes so much the more difficult to find any of them, without a vast loss of time.

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* Sometimes that inconvenience is unavoidable. Then their colour should form a contrast with that of the back ground. In certain situations the latter may vary, at different periods of the day. In that case, it has been found useful to paint the arms white and black, in large checkers, each occupying half the width, and half the length of the arm.

† And revised by a Committee of experienced Naval Officers.

Hence the advantages held out by the author of any very voluminous Telegraphic Dictionary, must always be in a great measure nugatory, unless the place of every phrase, or sentence contained in it, could be known by intuition, which is impossible.

It is to be observed, however, that the comparative compendiousness, of Sir Home Popham's Telegraphic Dictionary, is partly owing to a practice, which he has carried to the greatest possible extent, but of which, the other authors alluded to have availed themselves more sparingly, or not at all. I mean the system of classing under the same article of his Dictionary, and and thereby representing by one common signal, all the forms of the same verb, as well as every noun, adjective, or adverb, that happen nearly to coincide in sound, or are connected in signification. Thus the words, "agree," "agrees," "agreed," "agreeing," "agreeable," "agreeably," "agreement," "agreements," would all be denoted by one and the same signal, and comprehended under one article, in Sir Home Popham's Telegraphic Dictionary.

It is remarkable, how very few ambiguities, this sweeping method of classing the words of our language will be found to occasion, in practice, as may be ascertained by taking any sentences, at random, out of a book, and applying Sir Home Popham's Telegraphic phraseology to them. And yet it cannot be denied, but that serious mistakes may arise at times from this system.

For example, the following phrases, "They are robbing," "They are robbed," and "They are robbers," although different in sense, would all be expressed by the same signal in Sir Home Popham's Dictionary. The phrases, "A robber has "been executed," and "A robbery has been executed," would also be expressed by the same signal, and the phrases "They "are going," and "They are gone," would likewise be confounded.

It is further to be remarked, that Sir Home Popham's Telegraphic Dictionary, being necessarily confined to the use of the Royal Navy, is not available for general service: and even if this restriction did not exist, it is evident, that if Telegraphs were introduced into British India, or into any other of our foreign possessions, a number of military phrases and sentences, and a great number of local words and phrases would require to be introduced, which are not to be found in Sir Home Popham's Book: and at the same time, it might be desirable to obviate the degree of ambiguity, before mentioned in that work. This would require every verb to be expressed in two forms instead of one, and some of the nouns, adjectives, and adverbs, now classed under the same head with a verb, or with each other, to be expressed separately. For example, the word *Rob*, and others connected with it, which are at present all denoted by the same signal, might be divided into three distinct signals, in the following manner.

1st. *Rob, robs, robbing, robbery, robberies*, and to follow the same rule in regard to other verbs, including the present tense, the infinitive, and active participle, under the same head, and also any noun of the same sound, or even of kindred meaning, provided, in the latter case, that it be an action, passion, or any thing inanimate.

2d. *Robbed*, including always the past tense of the verb, and the passive participle, under one head, whether they be the same in sound or not.

3d. *Robber, robbers*, and to follow the same rule in regard to personal nouns, keeping them always distinct from the verbs.

It appears also advisable, that the adjective and adverb, when different in sound, although of kindred meaning, should likewise be separated from the verb. Hence it would be proper to separate the various words classed under the head *agree*, in Sir Home Popham's Telegraphic Dictionary, as follows.

1st. *Agree, agrees, agreeing, agreement, agreements.*

2d. *Agreed.*

3d. *Agreeable, agreeably.*

If a select Dictionary on Sir Home Popham's principle were thus dilated, it would, in all probability, increase the contents of the work from 18,000, to about 25,000 words and sentences, and if the military and local phrases before alluded to were likewise added, it probably might swell the amount to near 30,000. Upon the whole, I conclude, that a judicious Telegraphic Dictionary, composed on the most comprehensive plan, so as to embrace every contingency of the public service, both at home and abroad, ought not to contain so many as 40,000 articles. This inference may be considered the result of experience, inasmuch as it has been drawn from a careful comparison of the most elaborate works of that nature, that I have been able to procure.

Supposing a Dictionary of this description to be composed, I would adapt it to the key of the Universal Telegraph, in the following manner.

The Dictionary should be divided into five parts or classes, each containing one fifth part of the total number of articles inserted. Thus, for example, if 30,000 articles, and 1000 blanks for unforeseen purposes appeared necessary, let each division of the book contain 6000 articles, and 200 blanks.

Of the 28 signs, which the Universal Telegraph is capable of exhibiting, I would reject one, namely, position 4 of the day signals, in which one arm points vertically upwards, in the direction of the post prolonged; because it has been urged, that unless when viewed by a very experienced eye, it is liable to be confounded with the post, so as to be mistaken for the position called " the stop", in which neither of the arms is shown.*

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* This sign is used to mark the end of a word, when several successive signals are all made alphabetically. In the stop, the indicator appears nearly equal in

Of the remaining 27 signs, *one* should be used as an *Alphabetical Preparative*, *one* as a *Numeral Preparative*, and *five* as *Dictionary Preparatives*, each of the latter referring to its own distinct part, or class of the Dictionary.

Thus there would be 7 preparatives, and 20 signs for general purposes. Each preparative would of course denote, not only the beginning of that word or sentence, which is immediately to follow it, but also the end of the preceding one.

In representing the letters of the alphabet by 20 signs, the letters I and J, the letters K and Q, the letters S and Z, and the letters U and V, would be coupled together: but the letter F would require to be denoted by the two successive letters, P H, and the letter X, by the two successive letters, C S or K S.

The number of signals, which may be made by three successive changes on the Telegraph, using the 20 disposable signs only, is equal to 8000, being the third power of 20; but as the beginning of each signal must be denoted by a preparative, without which the signal is imperfect,. if the above 8000 articles be combined with the five Dictionary preparatives before mentioned, it will be evident, that by never using more than four changes on the Telegraph, for any article of the Dictionary, no less than 40,000 words and sentences may thereby be exhibited: but, as I remarked before, this number is greater, than appears to be absolutely necessary, in a judicious and well composed Telegraphic Dictionary.*

5th. *GENERAL OBSERVATIONS.*

I was for some years persuaded, that my Telegraph of 1804, was the first that fully developed the principle of the arm, or moveable index attached to a post, and displaying eight distinct positions, of which at least six or seven are significant.

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length to the upper part of the post. In No. 4 position, it is not quite half so long as the same part of the post appears to be, when prolonged by the addition of the arm. Hence the experienced or careful observer will scarcely mistake between these two. No. 4 of the night signals is one of the most conspicuous signs.

* Lieut. Jacob of the Hon. East India Company's Bombay Artillery, is now employed in compiling a Dictionary, to suit the Universal Telegraph, which he proposes to adapt more especially to the service of British India.

I have since discovered, that the same principle, which seems now to be considered the distinction of that species of Telegraph, recently styled the Semaphore, had been previously adopted, although not to my knowledge, both in this country, and in France*. Mr. Edgworth first made use of the eight Semaphoric positions,† in a Telegraph, constructed by him in Ireland, in 1794, and the Reverend J. Gamble, in his radiated Telegraph, invented in 1795, first used the Telegraphic arm and post, but not the Semaphoric principle of motion.

The French Semaphore, invented according to M. Dupin, in 1803, combines the Telegraphic arm and post, with the Semaphoric principle of motion, previously adopted by Mr. Edgworth. It appears, however, to have been preceded in France, in the year 1796, by a very complex Telegraph, upon a similar principle, having no less than seven Semaphoric arms, disposed upon an immense wooden frame, which was in a short time afterwards abandoned, as I am persuaded, that all

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* Signals of some kind appear to have been used in the earliest ages; but the first description of a Telegraph, properly so styled, is given in Polybius. It is a nocturnal Telegraph, communicating intelligence alphabetically, by the combinations of 10 torches. A passage of Vegetius implies, that the Romans made day signals, by means of beams, exhibiting, in all probability, the identical positions of the present Telegraphic arm.

The invention of the modern Telegraph may justly be ascribed to the celebrated Dr. Hooke, for the obscure hints of the Marquis of Worcester, in his Century of Inventions, although of prior date, scarcely seem to merit attention, since he has not put his ideas in a tangible shape. Dr. Hooke's paper on the subject of the Telegraph, was read to the Royal Society of London, in 1684. His plan may be called the Symbolic Telegraph, since he proposes to use a distinct symbol for each of his Telegraphic signs, the whole of which were to be contained in a large chamber or reservoir, from whence they were successively to be drawn forth into view, as required, and afterwards obscured again, by means of a couple of ropes and pulleys, acting laterally. Most of Dr. Hooke's practical rules for telegraphing have been proved by after experience, to be the best that could have been suggested.

M. Chappe, in France, has the merit of proposing the first Telegraph, that was carried into effect as a permanent establishment. This machine was erected in 1793, and is sometimes called the T Telegraph, from its appearance when at rest.

† The positions of a Telegraphic arm, or index, are necessarily limited to that number; for the rudest eye can distinguish between horizontal and vertical, and one intermediate degree of obliquity between these two, which will give in all eight positions: but the observations of the signal man on the look out, would be attended with great delay, and the most experienced eye would be liable to frequent errors, if more than one oblique angle were introduced between horizontal and vertical, especially as refraction would then come into play; and in that case also, no simple method could ever be permitted of moving the Telegraph, the machinery of which would invariably require the precision of clockwork.

On these grounds, I consider Mr. Garnet's plan of exhibiting 24 Telegraphic signs, or any other plan pretending to exhibit more than 8 positions, by one index, as perfectly inadmissible.

Telegraphs, which aim at prodigious powers, must necessarily be, when tried by the test of experience. In fact, Mr. Edgworth, who at first proposed a Telegraph of four bodies, to be worked by four men, afterwards found, on trial, that the successive changes of one of these bodies, worked by one man only, could make the same signals, very nearly as quick as the former,* which he therefore abandoned, in the same manner, as I have since been induced to relinquish the idea of my Polygrammatic Telegraph.

The principle of motion introduced by Mr. Edgworth, when applied to the Telegraphic arm, is undoubtedly the best method of making distant signals by land; and, in fact, the superiority of what is called the Semaphore over the Shutter Telegraph, formerly in use in this country, is now generally acknowledged. As the latter, however, has still some few advocates, I shall briefly point out the disadvantages attending that construction, by comparing together the simplest forms of these two instruments.

On consideration, it will be found that five shutters, as proposed by Mr. Gamble, in 1795,† are the smallest number, with which an effective Shutter Telegraph can be composed; and that the two-armed Telegraph, proposed by me, is the simplest form of the other. Now in regard to the construction, I calculate that the materials necessary for making five shutters, and the frame work for supporting them, will be sufficient for three Day Telegraphs upon my principle; and that the former, when all its shutters are displayed, will expose at least five times as great a surface, to the action of the wind and weather.*

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* Mr. Edgworth's bodies are isosceles triangles, each moving round its own center of gravity, upon a pivot near the top of an upright pillar or post. The base of the triangle being only half its height, the very acute angle at the vertex serves as the index of the several Telegraphic signs or positions. Three parts of Mr. Edgworth's Telegraph of 1794, are equivalent to the French Semaphore of 1803, and two parts are equivalent to Sir Home Popham's Ship Semaphore of 1816. Mr. Edgworth's final plan, consisting of one part only, and having no more than seven significant signs, can scarcely be considered an efficient Telegraph, since it is entirely incompetent to the alphabetical mode of communication; and it cannot even exhibit 40,000 signals, taken from a Dictionary, without going as far as seven changes, for a great proportion of them.

† This Gentleman, then Chaplain to His Royal Highness the Commander in Chief, appears to have been the first inventor of the Shutter Telegraph, although the Admiralty, by whose authority he tried his first experiments, did not eventually adopt his plan. In Mr. Gamble's Shutter Telegraph, the boards being all placed vertically over each other, there can be no ambiguity, and consequently no necessity for an indicator: but this advantage must have been accidental, since he lost sight of that principle, in the radiated Telegraph afterwards invented by him, which was established in Minorca in 1800, by order of General Fox, and in Sicily in 1806, by order of Sir John Stuart. A Shutter Telegraph of 10 boards, disposed in three vertical tiers, appears to have been published in Sweden by Mr. Edelcrantz, in 1796, which is on a scale of magnitude, only exceeded by the plan of Lieut.-Colonel Macdonald. Mr. Edelcrantz also proposed to exhibit 10 lamps by night, one in each compartment of his Telegraph.

Independently of this disadvantage, it will be evident, that no one shutter out of the five (or out of whatever number may be used) can possibly be distinguished from any other shutter, unless the whole of the bulky frame work, necessary for supporting them, can at the same time be distinctly seen. But this frame work is in itself so very complex an object, that it causes the signs of that species of Telegraph, when seen through the telescope at a certain distance, to appear almost a mass of confusion. And, in fact, they may justly be styled so, when compared with the simple forms of the Semaphore. The reader may easily convince himself of this remark, by sketching upon paper a few of the signs, or combinations of both, on as small a scale as possible, which is one of the best methods of judging of the comparative clearness of any two Telegraphs.

Before I proceed further, it is proper to acknowledge, that the exhibition of Telegraphic signals, both by day and night, upon one and the same instrument, is by no means a new idea. In fact, I have somewhere read, that M. Chappe, the inventor of the first French Telegraph of 1793, proposed to make nocturnal signals also, merely by the addition of a certain number of Argand's lamps; but on considering the peculiar form of that instrument, I do not think that it can possibly exhibit an adequate number of night signals, in any manner sufficiently simple, and at the same time free from ambiguity. The efforts hitherto made in this country to effect the same object, in a simple manner, have, I believe, generally proved unsatisfactory, since it has usually been considered indispensable, to distinguish one or more of the lights from the others by colour, which, on trial, has always been found impossible, unless at such very short distances, as are absolutely unfit for Telegraphic purposes. If the plan suggested in this paper should be admitted to have surmounted the difficulty, hitherto attending this problem, it can only be ascribed to the useful principle of the indicator having been previously adopted.*

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* Assuming, that in order to be equally distinct, the side of the square shutter should be ⅔rds of the length of the Telegraphic arm: also that the width of the principal parts of the frame of the former, must be equal to that of the Telegraphic post.

As, I believe, it will scarcely be disputed, that the two-armed Telegraph proposed by me, is the simplest and most economical form, consistent with efficiency, in which the kind of Telegraph, called the Semaphore, can possibly be exhibited; and as the only objection that can be urged against it, even in theory, is its want of power, I shall briefly consider, what would be the result of attempting to modify the construction, with the view of obtaining a greater number of Telegraphic signs than 27 or 28, to which it is limited.

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* Take away the indicator, and the signs free from ambiguity, which the Universal Telegraph can exhibit, will be diminished to 15 by day, and 12 by night.

Various nocturnal Telegraphs have been proposed in this country. In the Encyclopædia Britannica, there is a description of one, consisting of four moveable lights, each having a vertical motion only. The chief objection to this simple plan is, that the number of signs free from ambiguity, is insufficient for Telegraphic purposes. Mr. Garnet, whose day Telegraph was before alluded to, proposed to make the same 24 positions by night, by attaching two lamps of different colours, to the extremities of his index. Both of his projects will, no doubt, appear chimerical to the practical signal officer, although they have been noticed with applause, in some works of reputation. Mr. Boaz took out a patent in 1802, for a nocturnal Telegraph, consisting of the enormous number of 25 fixed lights, disposed in the form of a square. Mr. Mac Arthur published the plan of a nocturnal Telegraph, to consist of six lights, in the Naval Chronicle, in 1797; and in 1807, I published, in Tilloch's Philosophical Magazine, one consisting of the same number of fixed lights. I have no recollection of Mr. Mac Arthur's plan at present. In regard to my own, I can only say, that having reconsidered it, at this distance of time, I do not attach the smallest value to it. On showing the plan of my Universal Telegraph, last year, to Vice-Admiral Sir Benjamin Hallowell, he informed me, that a project, similar to it in principle, had been suggested some years before by Lieutenant Alphonso Henry, of the Royal Navy, who attempted to convert Sir Home Popham's Ship Semaphore, into a nocturnal Telegraph, by the addition of lanterns, using six in all, namely, two fixed lanterns to each of the two posts, and one moveable lantern to each arm. It was a remark, previously made by Sir Benjamin, in the course of conversation, as to the utility of an improved system of night signals, that induced me to turn my mind once more to this subject, which, in all probability, I should otherwise never have thought of. Sir B. Hallowell tried experiments himself, with that view, in 1801, in which he used for his night signals, transparent or illuminated numeral figures, not the combinations of lanterns. Lieut.-Colonel Macdonald in 1817, published several systems, for exhibiting nocturnal signals, on a scale of extraordinary magnitude. One of his night Telegraphs, for example, is formed by means of 13 lamps, attached to an apparatus, consisting of a mast 80 feet high, having 3 yards, each 45 feet in length, slung across it, and supported in the usual manner. In some of his plans, but not in this, he uses a contrivance equivalent to what I have called the indicator.

It will be evident, that in making Telegraphic signals alphabetically, little or no advantage can be obtained from using more than 27 signs. It therefore only remains to consider, what difference will arise from using more than the above number of signs, in reference to a Telegraphic Dictionary.

When the simple two-armed Telegraph is applied to such a work:

The number of words and sentences that can be exhibited

By 2 changes on the Telegraph will be 20 × 5 = 100
By 3 changes - - - - - - - - - - - 20 × 19 × 5 = 1,900
By 4 changes - - - - - - - - 20 × 19 × 20 × 5 = 38,000
Total 40,000

Now we shall suppose a two-armed Telegraph to be formed, capable of exhibiting 48 distinct signs. Let us compare its powers with the former.

Of the above signs, let us suppose *one* to be used as an *Alphabetical Preparative, one* as a *Numeral Preparative,* and *sixteen* as *Dictionary Preparatives,* leaving 30 signs disposable for general purposes.

Applying this arrangement to a Dictionary of words and sentences, the number of articles capable of being exhibited

By 2 changes on the Telegraph will be 30 × 16 = 480
By 3 changes - - - - - - - - - - 30 × 29 × 16 = 13,920
By 4 changes - - - - - - - - 30 × 29 × 30 × 16 = 417,600
Total 432,000

On comparing the above results together, it will therefore appear, that the Telegraph of 48 signs can exhibit no less than 432,000 signals by four changes, whereas the Telegraph of 27 signs can only exhibit 40,000 signals by the same number of changes. This, in theory, appears a vast superiority, but, in practice, it is attended with very little advantage; for we before saw, that 40,000 signals are sufficient for the most comprehensive plan, upon which a Telegraphic Dictionary ought to be composed. The 392,000 extra signs of the more powerful

Telegraph are therefore absolutely useless. The only real advantage is, that it can make, by *two* changes, 380 signals, which the simpler Telegraph cannot make with fewer than *three* changes; and that it can make by *three* changes 12,020 signals, which the simpler Telegraph cannot make with fewer than *four* changes. The real superiority, therefore, of the more powerful Telegraph, when thus analyzed, is trifling in itself, being generally in the ratio of 4 to 3; and extending only to about one third part of the total number of signals, that would probably be required in practice. Hence it can scarcely be deemed a consideration of sufficient moment, to enter into competition with the superior economy, and clearness, of the simpler instrument.

For the above reason, I gave up an idea, which suggested itself, of doubling or trebling the powers of my two-armed Telegraph, by using the day indicator as an effective arm, giving to it, either the two positions, 2 and 3, or the three positions, 1, 2, and 3, of the regular arms. By either of these arrangements, it would still act as an indicator, by appearing upon one side of the post only, but by the former, it would increase the Telegraphic signs from 28 to 56, whilst, by the latter, it would increase them to 84. Upon due trial, I found that both the observer at the telescope, and the operative signal man, were so much embarrassed, by having an additional object to attend to, that they were absolutely obliged, for the sake of accuracy, to sacrifice more in time than they gained in power. The attempt at 84 signs was, however, the most objectionable of the two, for in this case the operative signal man could not move both arms and the indicator simultaneously; but was obliged to work the Telegraph by two successive motions, which is a great disadvantage.

There are, however, other methods of increasing the power of the two-armed Telegraph, without using the indicator, in such a manner as virtually to become a third arm.

One of these methods consists in using two arms upon the same pivot, distinguished from each other, by some visible difference of form, like the hour and minute hands of a clock.* This would at once double the signs of the two-armed Telegraph, so that their number would be increased from 27 or 28, to 55 or 56.

There are, however, two very serious objections to this arrangement. In the first place, whether the addition made to one of the arms be in the form of a cross, or of a heart, its length, or breadth, measured transversely, that is, in a direction perpendicular to the arm, must be at least three times the breadth of the latter, and it must necessarily be placed at a distance from the center of motion. Hence it will expose a great surface, with a considerable leverage, to the action of the wind. Secondly, unless the observer at the telescope be exceedingly expert, he will be liable to make constant mistakes, between the two arms: and even after he has attained a certain dexterity, he will always be obliged to inspect each sign for a longer space of time, than if they were both exactly alike. The operative signal man will also be obliged to work with less confidence and rapidity. These objections appear to be conclusive against adopting this construction.

Another method of increasing the power of the two-armed Telegraph, is to place the arms upon different pivots, as has been done by Sir Home Popham, in his Semaphores, which were before described. By this means 48 Telegraphic signs are obtained, instead of 27 or 28. But I have already shown, that this superiority of power, even if the utmost advantage be taken of it, is very trifling when applied to practice, although it may appear of much importance, on the first hasty view of the subject. Moreover, by the present Admiralty practice of Telegraphing, it is absolutely useless, as I before stated: for in that Department, signals are either made alphabetically, and for that method 27 signs are, of course, amply sufficient; or by the Telegraphic Vocabulary, before mentioned, which was compiled by Sir Home Popham, for the use of the Royal Navy.

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* This is an old idea, for it appears to have been suggested to Mr. Edgworth in 1796, as an improvement upon his Telegraph. It was, however, rejected by that Gentleman, and I do not know, that it has ever since been proposed, or carried into effect.

Now the symbols used in that Vocabulary, to denote the various articles contained in it, are composed of the combinations of 28 Telegraphic signs only, so that they fall completely within the power of the Telegraph, described in this paper. In fact, if Sir Home Popham had undertaken to compose a Vocabulary for the purpose, he could not possibly have adopted a system better suited to my Telegraph, than the present code of Naval signals.*

To use an apposite comparison: if all the sounds of the Italian language can be expressed by the 25 letters of the Roman alphabet, where would be the advantage of introducing into Italy, another alphabet of greater power. In like manner, if the 27 signs of the simple two-armed Telegraph be sufficient for Sir Home Popham's own Code of Signals, where is the use of applying to that Code, the larger, more expensive, and more complex instruments contrived by him, having one-and-twenty superfluous signs, over and above the number absolutely necessary.

For the service of ships, whether in harbour or at sea, there cannot be a doubt of the superiority of my plan over Sir Home Popham's Ship Semaphore, which is liable to constant difficulties and error; for it is not always easy to distinguish one of his two posts from the other, even at the commencement of a message; and when two ships, communicating with each other, are acted upon by the wind or tide, which is usually the case, their comparative changes of position will often, during the middle of the message, bring the posts observed into the same alinement, or even cause them to cross each other. Hence it becomes impossible to discriminate properly between them, for any length of time. Moreover, in ships under sail, my single post, which is entirely free from the above source of error, may often be seen, when a second post could not. Independently of this powerful objection, which must necessarily cause the present Ship Semaphore to be laid aside, sooner or later, it is undoubtedly a disadvantage to use two kinds of Telegraphs, instead of one, in the same branch of the public service; for the signs of the present Admiralty Land and Ship Semaphores, although expressed by the same numbers, have a very different appearance to the eye; which is, at first extremely perplexing to the signal men at the principal Sea ports, where these two kinds of instruments must necessarily communicate with each other. It is also to be observed, that these two Semaphores are of such a nature, as to render it impossible to engraft any simple system of nocturnal signals upon them. But it would be superfluous to enlarge further upon this subject, as I have said enough to illustrate the comparative advantages of the Telegraph described in this paper, which is equally efficient in all situations, and at all times, by sea as well as by land, by night and by day.

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* In adapting the key of the Universal Telegraph to Sir Home Popham's Telegraphic Vocabulary, *three signs* only are used for the *Alphabetical*, *Numeral*, and *Dictionary Preparatives*, *one sign* is used to denote *Ship's Name;* the others are left disposable for general purposes.

If it were required to adapt the key of the Universal Telegraph, to a Telegraphic Dictionary having numeral symbols, such as were formerly used in the Royal Navy, and which are still used in the Hon. East India Company's ships, and have recently been adopted by British Merchant vessels, I would appropriate *three signs* for the *Alphabetical*, *Numeral*, and *Dictionary Preparatives*, *ten signs* as *Numerals*, from 1 to 10 or 0 inclusive, of which the last in order should signify, when initial or single, the number 10, but when intermediate or final, the cypher 0. *One sign* should be used as a *substitute*, to denote the repetition of the preceding sign. The remaining 13 disposable signs, as applied to the Dictionary, should denote the numerals corresponding with the actual positions of the Telegraphic arms. Thus, for example, the two successive signs 35, and 16, if included amongst the disposable signs, would signify the signal 3516, which otherwise could not be expressed by less than 4 successive signs, taken from amongst the ten regular numerals.

I before stated, generally speaking, that a Telegraph may lose in time, what it gains in power. To apply this remark to the French Semaphore, that instrument, which has three arms, on different pivots, attached to the same lofty post, is capable of exhibiting, by three changes only, all the articles of the most voluminous Telegraphic Dictionary that can be imagined.* But to counterbalance this superiority of power, it must either be worked by *two* operative signal men, instead of *one*, which is, of course, a very serious disadvantage, or, if one man only be employed, he must lose time by working the arms, not simultaneously, but successively, in two distinct motions.* Moreover, the observer at the telescope, having three objects to inspect, at some distance from each other, would be at least twice as long in distinguishing the signs of the French Semaphore, as he would be in making out those of the simple two-armed Telegraph, which are seen at one glance of the eye. Hence time might be lost, not gained, by adopting the more bulky, complex, and expensive instrument.

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* The French Semaphore can make 342 signs, of which, however, it might not be prudent to use more than 306, even if an indicator were added, to prevent the degree of ambiguity, to which that instrument is at present liable. Now, strictly speaking, the combinations of 306 signs are numerous enough to make 40,000 signals by two changes only: but this arrangement would exclude the use of preparatives, or stops; and I do not think that these can, with safety, be dispensed with, in my Telegraph, working by successive changes. I have, therefore, calculated upon the French Semaphore requiring to go as far as 3 changes, for a portion of its signals, in order to complete the standard number of 40,000.

It may be remarked, that if extraordinary power were really a desirable property of the Telegraph, the construction originally adopted by me, may appear preferable to all others, under the following considerations.

1st. *Four* parts of my Telegraph, which, supposing the arms to be 6 feet long, may either be disposed upon four posts, standing on a horizontal base of 46 feet, or may be attached to a mast 49 feet high, will exhibit by one change, every word and sentence of the most voluminous Telegraphic Dictionary, that can be imagined.

Six parts of Mr. Edgworth's Telegraph, disposed upon six posts, standing on a horizontal base of 74 feet, or *six* parts of the French Semaphore, attached to a mast 73 feet high, would be required for effecting a similar object. As for the Shutter Telegraph, we must leave it out of the question, for 20 boards would be required, covering, together with their frame, a space of monstrous magnitude, and forming signs that would be a perfect chaos.

2d. *Two* parts of my Telegraph, which may either be disposed on a horizontal base of 18 feet, or may be attached to a single post 25 feet high, will exhibit, by two changes, every word and sentence of a Dictionary of 80,000 articles.

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* Having only two hands, a man cannot turn more than two levers, or indices, [illegible] having a complete circular motion, at the same time. Hence it is impossible [illegible]e man to work properly, three perfect Telegraphic arms, like those of the [illegible]ch Semaphore. But any simple auxiliary to the two-armed Telegraph, hav-[illegible]nly one position, may be worked by a stamp of the foot, acting on a pedal. [illegible] was the method suggested to me, for moving the day indicator, at the time [illegible] I tried the experiment, before alluded to, of increasing the power of the [illegible]graph, by exhibiting that part of the machine in two positions. (See Page 24).

Three parts of Mr. Edgworth's Telegraph, disposed on a horizontal base of 32 feet, or *four* parts of the French Semaphore, attached to a mast of 49 feet, are required for effecting a similar object.

Hence, by adopting pairs of arms upon my principle, instead of independent arms, on Mr. Edgworth's, or on the Semaphoric principle, there will be a saving in all cases, either of base, or of height, accompanied by a corresponding saving of materials and weight. The comparative power of these three methods, stated more precisely, is as follows.

One part of my Telegraph yields 27 distinct signs, one part of Mr. Edgworth's 7, one part of the Semaphore 6.

Two parts of my Telegraph yield, on different posts, 783 signs, on the same post 615. Two parts of Mr. Edgworth's Telegraph yield 63 signs: two parts of the Semaphore 48.

Three parts of my Telegraph yield, on different posts, 21,951 signs, on the same post 13,551. Three parts of Mr. Edgworth's Telegraph yield 511 signs: three parts of the Semaphore 342.

Four parts of my Telegraph yield, on different posts, 614,655 signs, on the same post 298,143. Four parts of Mr. Edgworth's Telegraph yield 4095 signs: four parts of the Semaphore 2400.

Five parts of Mr. Edgworth's Telegraph, for it is needless to go further with mine, yield 32,767 signs; five parts of the Semaphore yield 16,806.

Six parts of Mr. Edgworth's Telegraph yield 262,143 signs; six parts of the Semaphore yield 117,648.

Here it also appears useless to proceed further with either of these two methods, for as the parts of each, taken singly, are inadequate to express the letters of the alphabet, the only object in extending them would be to enable them to meet the whole contents of a Telegraphic Dictionary, for which one would suppose that 100,000 articles might suffice. The inventor of the great French Semaphoric Telegraph, said to have been erected in 1796, must, however, have thought differently, since he constructed it with *seven* parts, thereby obtaining no less than 730,230 signs or combinations.

In comparing the above three methods, it will, of course, be understood, that the several parts of Mr. Edgworth's Telegraph, and of the Semaphore, require the same strength and size of post as mine; and that the single body, or arm, of the two former instruments, also requires the same space to move in, as the pair of arms of the latter.

The power of Mr. Edgworth's Telegraph is superior to that of the Semaphore, partly from the circumstance of each part of the former being attached to a separate post, and partly also from his using, for the index of his Telegraph, an isosceles triangle, having its base equal to half its altitude, which form is not liable, like the Telegraphic arm, when pointing vertically upwards, to be confounded with the post. The triangle, however, appears to me, to be an inferior contrivance to the Telegraphic arm, for two reasons. First, it exposes a greater surface to the wind, than a Telegraphic arm equally conspicuous. Secondly, its signs are not by any means so distinct, of which you may judge, by drawing some very small isosceles triangles, and comparing them with lines of equal length, in corresponding positions.

In order to work the Universal Telegraph expeditiously, two men are required, one of whom is employed solely in observing with the telescope, noting down the signs exhibited, and in directing the other, who is the operative signal man. In the intermediate stations of a Telegraphic line, after the latter has exhibited the sign required, he runs to a second telescope fixed in the contrary direction, and as soon as he sees that the same sign is duly repeated by the next corresponding station, he reports it to the directing signal man, returning at the same time to the levers, in readiness to exhibit a new sign when ordered. The directing signal man must of course wait, until he receives such report, after each successive sign, before he orders another to be exhibited. If a mistake should be observed in the repetition of any sign, the operative signal man at the first station, must shake that arm, of which the position has not been properly repeated at the next. When two Telegraphs only are in communication with each other, the directing signal man is, of course, the sole observer. The telescopes used must always be properly pointed and firmly fixed, without the necessity of holding them in the hand. Attending to this precaution, we ascertained, that the longest messages may be made and repeated, by day, at the average rate of 8 signs per minute; which degree of expertness was attained after two or three days' practice, by two young officers of Engineers, and two non-commissioned officers, none of whom had any previous knowledge of telegraphing.*

It ought to have been observed before, that in time of war, the Universal Telegraph may be particularly useful in the field, but especially in the encampment of a besieging army, or in a defensive position, and in this case, as well as at Sea, the nocturnal signals, which may generally be dispensed with at permanent inland stations, as was before observed, will be no less important than the day signals. Also, that the regular horizontal distance of the indicator light, may be diminished about ⅓th, without inconvenience.

In reference to the mechanical construction, a friend acquainted with the effects of climate in India, has recommended, that in that country, no iron shall be used in the construction, and no wood, excepting the post, which may be of teak, and the nocturnal indicator rod, and brace, which may be of bamboo. The pannels of the arms, and of the day indicator, to be of light copper plate. All the other parts to be of brass, or of bronze.†

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* The night signals, although equally distinct, cannot be made quite so quick, as it is not proper to move the arms too rapidly, after the lanterns are fixed. It is to be understood, that in sending a message, the whole of it must be written down, and the proper signs found, by a reference to the Telegraphic Key or Dictionary, before the director, at the first signal station, sets the Telegraph to work. Also that in receiving a message, there should be no attempt made to decipher it, until the Telegraph has finished working.

† The arms of the present Admiralty Semaphores are counterpoised by a mass of lead, at the head of each. This method is altogether incompatible with the occasional use of lanterns, otherwise it would be the best for permanent stations, where lightness is not an object. Since the first sheet of this paper was printed, I have ascertained by experiment, that in working a Telegraphic arm by a rope, it is best to use pulleys with triangular grooves, or with notches of the same form, cut into projecting cleats, fixed to their circumference, in which case, the turns of the rope (described in page 10), which are extremely inconvenient in practice, may be dispensed with.

THE END.

EXPLANATION OF THE PLATES.

PLATES I, and II. THE UNIVERSAL TELEGRAPH.

The former explains the construction, the latter shows the appearance of the Telegraphic signs.

PLATE III. VARIOUS TELEGRAPHS, drawn on the same scale.

Fig. 1. Dr. Hooke's Telegraph, invented in 1684, showing one of his symbols, and the chamber or reservoir for containing them.

Fig. 2. The original French Telegraph of M. Chappe, adopted in 1793, sometimes called the T Telegraph.

Fig. 3. Mr. Edgworth's first Plan, by him styled " the Tellograph," invented in 1794.

Fig. 4. The Rev. J. Gamble's Shutter Telegraph, invented in 1795.

Fig. 5. The first Admiralty Telegraph, on the Shutter principle, proposed by Lord G. Murray, in 1795.

Fig. 6. The Rev. J. Gamble's Radiated Telegraph, 1795.

Fig. 7. Mr. Garnet's Telegraph, invented in 1794, or 1795.

Fig. 8. The first French Semaphoric Telegraph, said to have been erected on the Palace of the Thuileries, in 1796.

Fig. 9. Mr. Edgworth's final plan of the Tellograph, 1796.

Fig. 10. Idea of a Two-armed Telegraph, having one arm in the form of a cross, the other in the shape of a Sword Cutler's sign, suggested to Mr. Edgworth, in 1796.

Fig. 11. The French Coast Telegraph, called the Semaphore, said to have been invented in 1803.

Fig. 12. Captain Pasley's first Polygrammatic Telegraph, invented in 1804, published in 1807.

Fig. 13. Lieut.-Col. Macdonald's Shutter Telegraph, published in 1808.

Fig. 14. Captain Pasley's second Polygrammatic Telegraph, published in 1810.

Fig. 15. Rear-Admiral Sir Home Popham's Land Semaphore, adopted by the Admiralty, instead of the Shutter Telegraph, in 1816.

Fig. 16. Sir Home Popham's Ship Semaphore, also established in 1816.

Fig. 17. A Shutter Telegraph recently proposed in India, by Captain Swiney, of the Bengal Artillery.

Fig. 18. Lieutenant-Colonel Pasley's Universal Telegraph, as improved in 1822, upon his original plan of 1804.

Townsons and Burrill, Printers, Chatham.

Pl. 1.

UNIVERSAL TELEGRAPH.

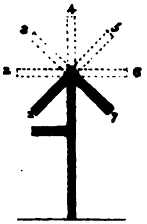


Fig. 1.

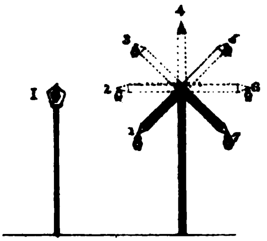


Fig. 2.

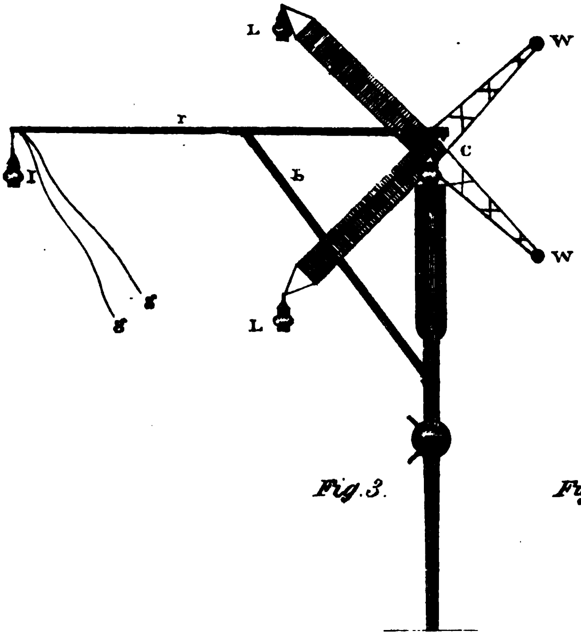


Fig. 3.

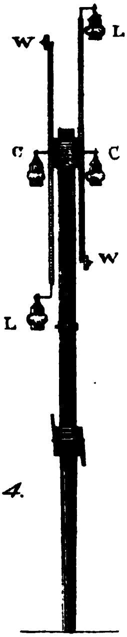


Fig. 4.

Drawn on Stone by R. Howe

UNIVERSAL TELEGRAPH.

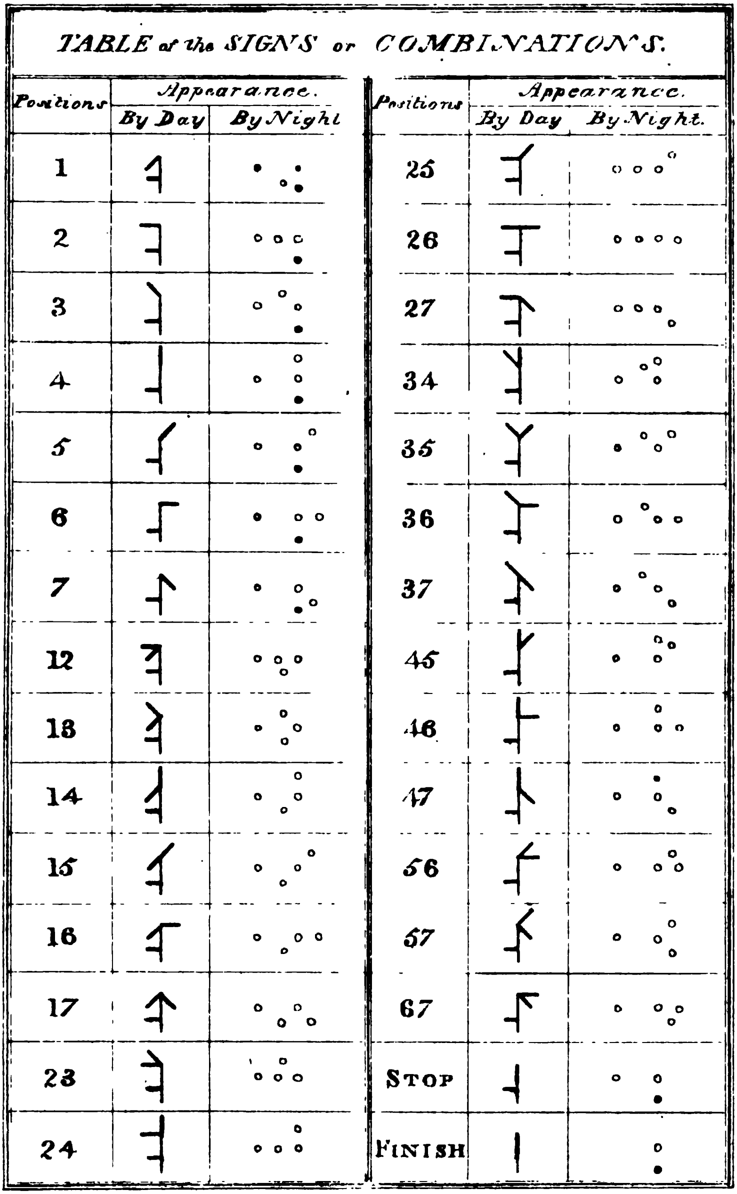


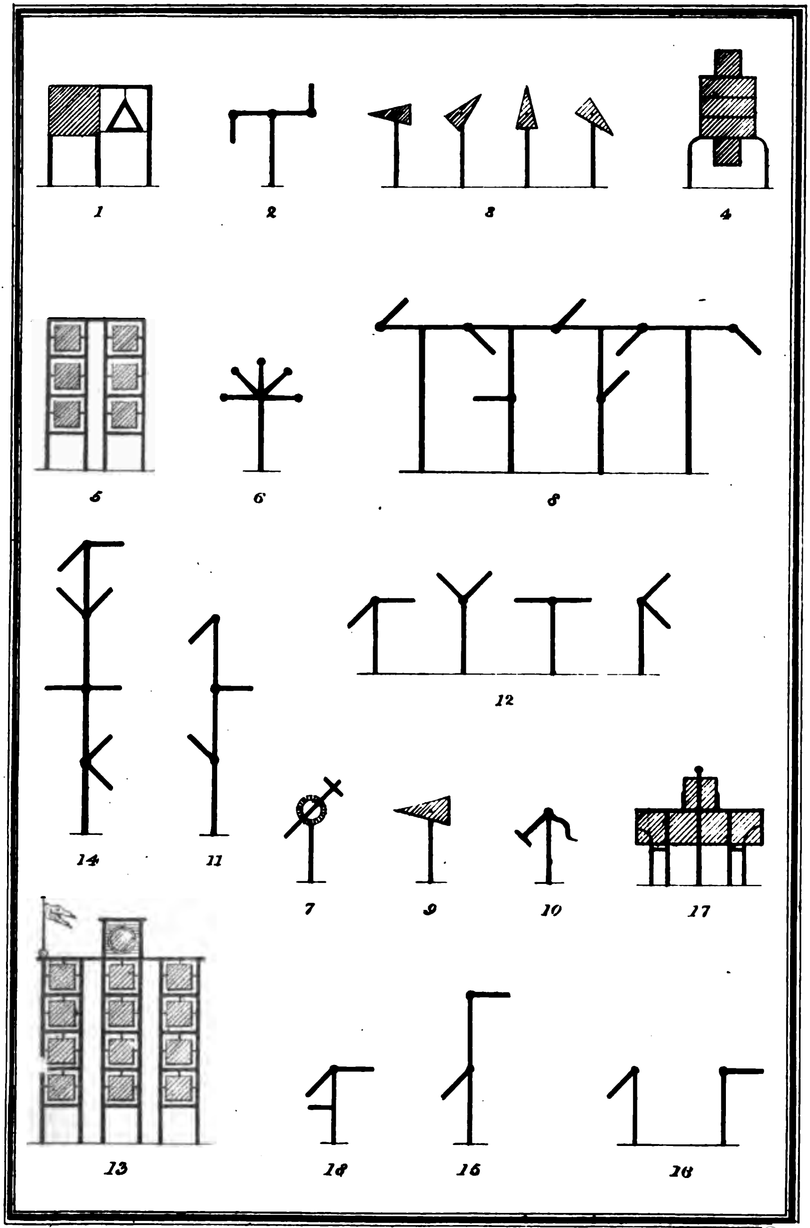
TABLE of the SIGNS or COMBINATIONS.

Positions	Appearance.		Positions	Appearance.	
	By Day	By Night		By Day	By Night.
1			25		
2			26		
3			27		
4			34		
5			35		
6			36		
7			37		
12			45		
13			46		
14			47		
15			56		
16			57		
17			67		
23			STOP		
24			FINISH		

Drawn on Stone by R. Howe.

Pl. III.

VARIOUS TELEGRAPHS
drawn on the same Scale.



Drawn on Stone by R. Howe.

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~~OCT 22 '51 H~~

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